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DOSE-TIME-DISTANCE CURVES FOR CLOSE-IN FALLOUT FOR LOW YIELD LAND-SURFACE NUCLEAR DETONATIONS

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Effects of Atomic Weapons

Technical Objective
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ABSTRACT

Radiation dose computations made with the NRDL dynamic fallout model for low-yield land-surface bursts have been used to show graphically the time after burst required for exposed personnel to accumulate certain doses from deposited fallout as a function of downwind distance from ground zero. The curves indicate that significant doses may be accumulated rapidly within several miles downwind depending upon the yield and wind conditions. Since the effects of airborne radioactivity (transit dose) were not considered in this study, the curves indicate total accumulated doses (deposited only) which are less than the total doses which would be expected otherwise.

SUMMARY

The Problem

Anderson's theory for close-in fallout[1] indicated that militarily significant radioactive fallout could be expected at extremely short times (within 15 to 20 minutes) after burst for low-yield land-surface bursts in the 1 KT to 100 KT range. The time versus distance relationship for radiation dose buildup to a given level varies with yield and wind conditions. To show this variation and to give an indication of the time available for action prior to the receipt of certain doses, a series of curves were prepared to depict the dose-time-distance relationship for doses of 150, 300, and 450 roentgens.

The Findings

For the wind conditions used in this study, it was found that at relatively short distances downwind (less than 5 miles) the deposited fallout from the lower yield weapons (1 KT, 10 KT) gives a faster accumulation of dose than that from the higher yield weapons (100 KT). Farther downwind the higher yield weapons result in a faster buildup. A light wind condition (7.5 knot constant wind speed) causes an early dose buildup (150 roentgens in less than 20 minutes) at short distances (less than 4 miles); whereas, a heavy wind condition (30 knot constant wind speed) causes the same early dose buildup out to greater distances (beyond 9 miles). The doses indicated are conservative since transit dose was not considered in this study.

ADMINISTRATIVE INFORMATION

In FY 1960, this project is being sponsored by the U. S. Army under Project Number OD 012-01-001 and by the Navy Bureau of Ships under R&D Project Number S-F011 05 12.

INTRODUCTION

Since radiation dose from deposited fallout can cause heavy personnel casualties and thus hamper essential combat operations, it is necessary that the time and distance variations of dose buildup be studied in detail. Previously, there has been a lack of knowledge concerning dose-time-distance relationships for low-yield land-surface bursts, especially in the region extending immediately downwind from ground zero. To help fill this gap in knowledge, this report presents the results of dose-time-distance computations made with the NRDL dynamic fallout model[1].

METHOD OF COMPUTATION

Dose were computed for every minute after burst up to two hours after burst for points at 1-mile intervals along the downwind axis of the fallout pattern[2]. Computations were made for yields of 1, 10, and 100 KT, each with constant-direction wind speeds of 7.5, 15, and 30 knots. The times and distances corresponding to acute doses of 150, 300, and 450 roentgens were extracted from the computations and used to prepare curves indicating the time after burst to accumulate a given dose at distances out to 20 miles downwind from ground zero. Since the values at ground zero are not considered accurate, the curves start at one mile or at a point where the data is considered reliable. A recent refinement to the D-model allows accurate computation of the ground zero values and this information will be published later as it becomes available.

RESULTS

The curves plotted from the computed values are presented in Figures 1 to 9. These curves show the time for a given dose to build up as a function of downwind distance from ground zero for a given wind speed and for three weapon yields (1 KT, 10 KT, and 100 KT).

DISCUSSION OF RESULTS

These curves give an indication of the extremely short time that is available for taking evasive action or for acquiring shielding protection if significant radiation doses are to be avoided at short distances downwind from low-yield land-surface bursts. The distances of interest are those at which personnel might survive the blast, thermal, and initial nuclear radiation effects and still be exposed to significant radiation doses from deposited fallout.

For example, a man located three miles downwind from a 10 KT land-surface burst under a 30 knot constant direction wind condition would survive the initial weapon effects, but Figure 9 shows that if he remained in the open for 15 minutes he would receive 450 roentgens. Figure 7 shows that this time would be 50 minutes for a 7.5 knot wind. The effect of wind can be seen by comparing curves in Figure 1 and Figure 3. It is seen that, for a 100 KT yield, light winds (Figure 1) result in an early dose buildup (150 roentgens in about 16 minutes) at short distances (out to about three miles); whereas, heavy winds (Figure 3) result in the same dose buildup at greater distances downwind (in the 4 to 8 mile zone).

In each of the figures the relative position of the curves indicate that as the downwind distance increases the earliest accumulation of a given fallout dose results from the 1 KT and 10 KT yields and then from the 100 KT yield. For example, Figure 3 shows that the earliest dose buildup results from the 1 KT yield out to 1.7 miles, from the 10 KT yield at distances between 1.7 and 5.3 miles, and from the 100 KT yield beyond 5.3 miles.

The dose-time-distance relationships shown in these curves do not include the effects of airborne radioactivity (transit dose).

CONCLUSION AND RECOMMENDATION

The important conclusion drawn from this study is that fallout dose can build up to militarily significant levels within several miles downwind from ground zero within 15 to 20 minutes after burst.

The dose-time-distance relationships shown by these curves indicate a need for further study of the doctrinal implications of military operations conducted in proximity to low-yield land-surface bursts at early times after burst.

Approved by:

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For the Scientific Director

REFERENCES

1. Anderson, A. D., Application of Theory for Close-in Fallout to Low Yield Land-Surface and Underground Nuclear Detonations, U. S. Naval Radiological Defense Laboratory Technical Report USNRDL-TR-289, 12 January 1959.

2. Anderson, A. D., A Wind-Measuring System for the Tactical Prediction of Fallout, U. S. Naval Radiological Defense Laboratory Technical Report USNRDL-TR-369, 15 October 1959.

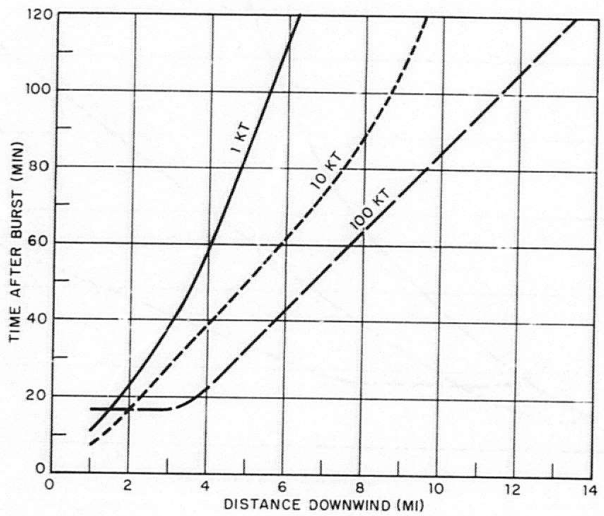

Fig. 1 Time After Burst of 150-r Dose Buildup Vs. Downwind Distance for 7.5-Knot Wind and 3 Yields

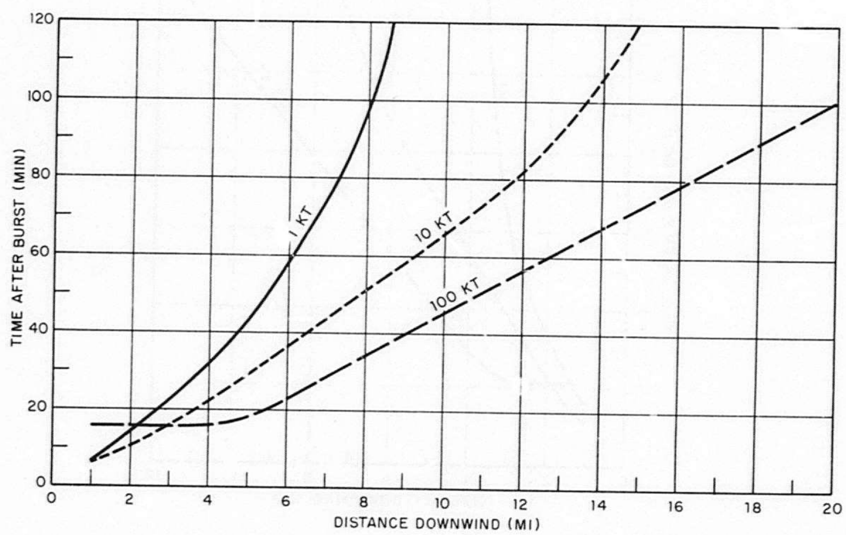

Fig. 2 Time After Burst of 150-r Dose Buildup Vs. Downwind Distance for 15-Knot Wind and 3 Yields

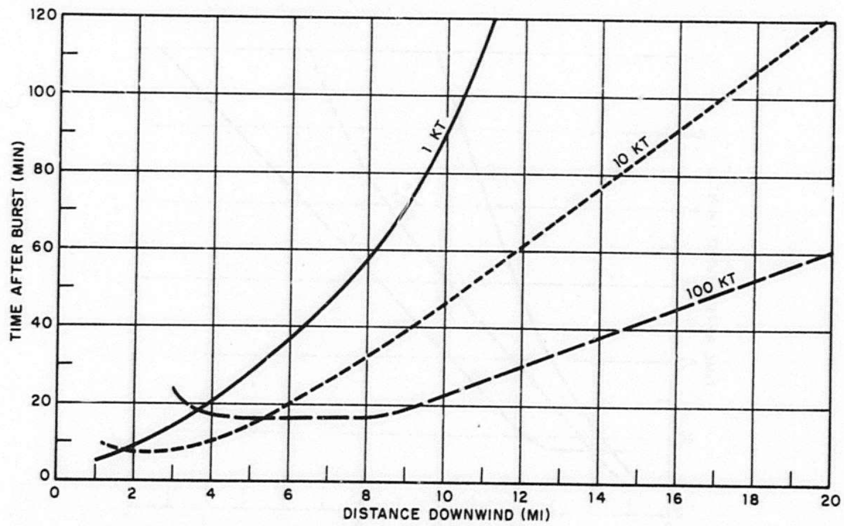

Fig. 3 Time After Burst of 150-r Dose Buildup Vs. Downwind Distance for 30-Knot Wind and 3 Yields

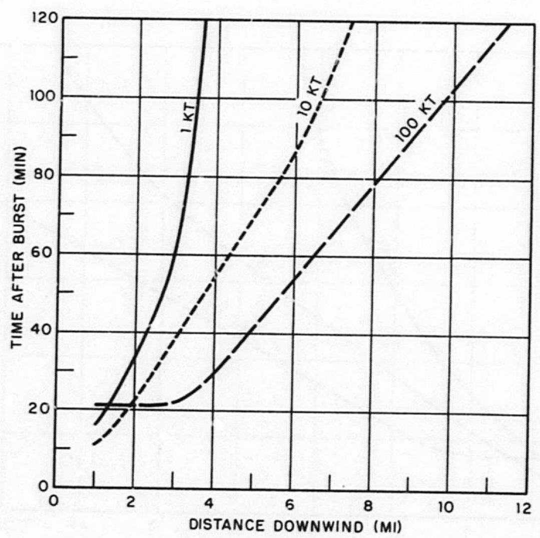

Fig. 4 Time After Burst of 300-r Dose Buildup Vs. Downwind Distance for 7.5-Knot Wind and 3 Yields

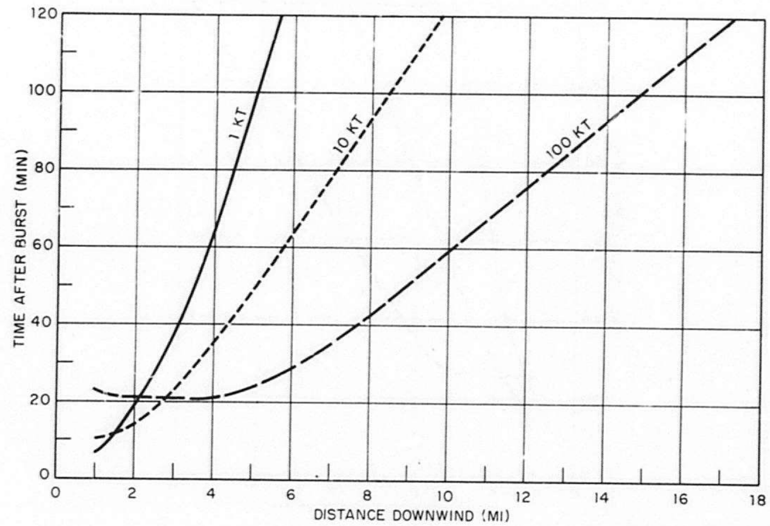

Fig. 5 Time After Burst of 300-r Dose Buildup Vs. Downwind Distance for 15-Knot Wind and 3 Yields

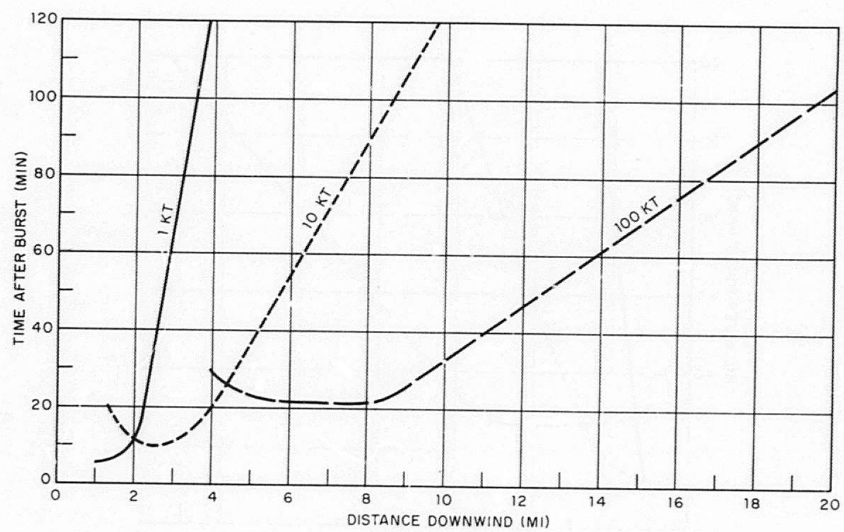

Fig. 6 Time After Burst of 300-r Dose Buildup Vs. Downwind Distance for 30-Knot Wind and 3 Yields

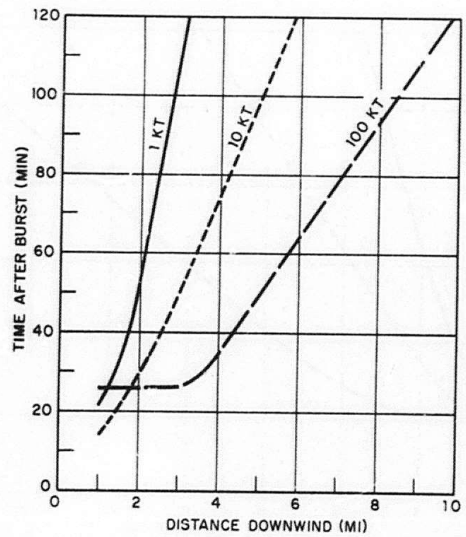

Fig. 7 Time After Burst of 450-r Dose Buildup Vs. Downwind Distance for 7.5-Knot Wind and 3 Yields

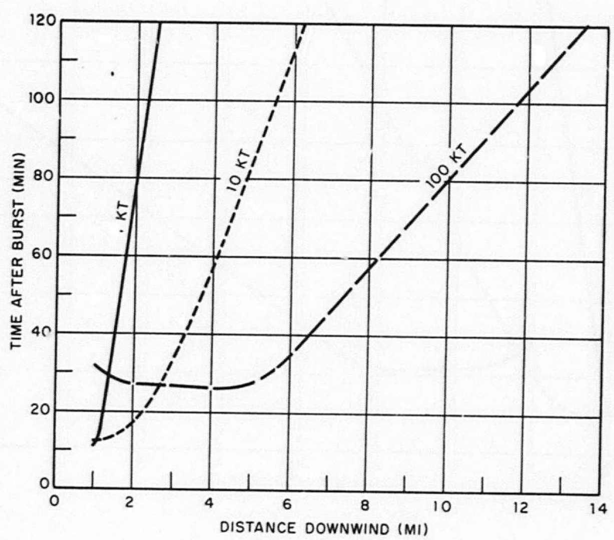

Fig. 8 Time After Burst of 450-r Dose Buildup Vs. Downwind Distance for 15-Knot Wind and 3 Yields

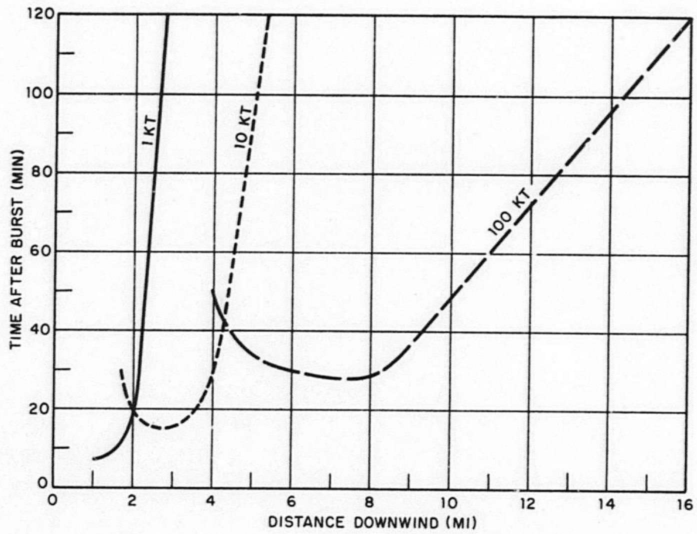

Fig. 9 Time After Burst of 450-r Dose Buildup Vs. Downwind Distance for 30-Knot Wind and 3 Yields